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Method for Improving a Tire Pressure Detection System with Indirect Measurement

The present invention relates to a method according to the preamble of claim 1.

Motor vehicles with electronic brake systems equipped with an ABS control (ABS: Anti-lock System), driving dynamics control, or systems of this type, frequently include programs for detecting a tire pressure loss which are able to detect such a tire pressure loss exclusively from the fact that rotational speed changes are encountered on the wheels as a consequence of the pressure loss. Further, it is known in the art to evaluate input signals of rotational speed sensors either alone or jointly with other sensors (yaw rate, lateral acceleration, etc.) in order to detect the driving situation.

The invention deals with the problem that spurious alarms in pressure loss detection systems (DDS) with indirect measurement, such as the method disclosed in DE 100 58 140 A1 in particular, become more frequent when the vehicle has a high point of gravity (e.g. due to a roof track) or when a trailer is coupled to the vehicle being equipped with the pressure loss detection system. These indirectly measuring pressure loss detection methods learn so-called reference values, which are basically used for a crosswise comparison of the individual wheels. In a four-wheel vehicle it has e.g.

gained acceptance to consider three independent reference values. A first reference value describes the relation between two wheels on one axle, a second reference value describes the relation between two wheels on the same vehicle side, and a third reference value describes the relation between two diagonally opposite wheels.

Tire pressure control systems with indirect measurement per se known in the art such as the system described in DE 199 61 681 A1, admittedly, have been improved already by taking into account driving parameters such as the yaw rate, etc. However, so far individual driving parameters have always been considered separately. A combined consideration of driving parameters is not described in the state of the art.

In view of the above, an object of the invention involves providing a method which improves the prior art indirect tire pressure control systems to such effect that a combination of several driving parameters are taken into account for the detection of tire pressure loss.

According to the invention, this object is achieved by the method as claimed in claim 1.

The method of the invention as a whole allows still further minimizing the tendency to spurious alarms of a pressure loss detection system such as DDS.

With the spread-out range of driving parameters, defined combinations of driving parameters are preferably declared as invalid. In a particularly preferred manner, only those reference values are used for the method to detect pressure

loss, which are determined at a time when the driving parameters considered lie within the range of parameters. The reference values not employed can be disregarded or corrected depending on the driving parameters under review.

It is possible to use not only the quantities of wheel torque, vehicle speed, lateral acceleration and yaw rate as driving parameters but also other quantities such as characteristic quantities for straight travel or cornering parameters, respectively, in particular the learning of a cornering parameter in a learning phase which takes place only in selected driving situations in an especially preferred manner, tire torsion and slip.

The driving parameter 'wheel torque' in this respect shall be considered as the wheel torque of a driven wheel or a quantity of corresponding behavior, with the wheel torque being in particular determined by way of a rating that results among others from engine data and power transmission data. The yaw rate and lateral acceleration in the disclosed method are either measured by sensors in a per se known manner or produced from wheel speed data.

It is preferred to use the driving parameters for the activation and/or deactivation of the data input in the pressure loss detection method or for the correction of the characteristic quantities found.

In the most simple, preferred case, the zone covered by the driving parameters is limited depending on the range of parameters by straight lines or two-dimensional or multi-

dimensional surfaces, respectively, what is, however, not imperative.

Preferably, at least three driving parameters are reviewed in combination.

The term 'stationary travel' implies that the motor vehicle is undisturbed to move straight on, under conditions as ideal as possible. The 'imaginary curve' can e.g. be determined by recording the wheel torque M at the driven wheels during stationary travel for all possible driving speeds v. A function M(v) is hereby achieved.

Advantageously, the method of the invention permits evaluating the influence of wheel load and wheel torque on the wheel slip. The accuracy of the pressure loss detection system (DDS) with an indirect measurement profits from the result of this evaluation.

Preferably, the method for pressure loss detection comprises a learning phase and a comparing phase. In the comparing phase subsequent to the learning phase the currently determined reference values are compared with thresholds that can be produced by means of learnt reference values.

The reference values are preferably produced from wheel speed data by calculation of a quotient of sums. The reference values are averaged and/or filtered in particular. Some or all of the driving parameters are also averaged and/or filtered in an especially preferred manner.

It is preferred to learn the reference values individually for several speed intervals. It is also preferred to carry out the comparison in the comparing phase individually in different speed intervals.

Preferably, a curve parameter is additionally produced and learned in the driving situation 'straight travel', and it is possible in a particularly preferred manner to employ a second straight travel detection method in order to detect this driving condition.

In some vehicles (e.g. vehicles without ESP), the wheel speed data for determining the driving parameters cannot be obtained directly from data defined by sensors (yaw rate sensor and similar sensors). The driving parameters can be produced from the wheel speed data in these vehicles (so-called 'ABS-Only' vehicles). Preferably, it is not the wheel speed data calculated in the function module for the anti-lock system (ABS) that is used but the raw data being used by the wheel speed sensors in an uncorrected fashion. A particularly high rate of accuracy of the tire pressure detection system can be achieved this way.

A detection of straight travel, which is comparatively less accurate, can be carried out by means of a separate method (second straight travel detection method). Preferably, already learnt values of the first straight travel detection method are rejected when cornering is detected by the second straight travel detection method. This second method in particular recognizes also when the assumption 'straight travel' for learning the inverting curve radii was wrong. The learning operation is rejected then. Criteria for

activating/deactivating the indirectly measuring pressure loss detection method (DDS) can be derived from an estimated yaw rate and lateral acceleration.

Further features and advantages of the method of the invention can be taken from the following description of the only Figure.

With reference to Figure 1a, the wheel torque M is plotted against the vehicle speed v. Curve 1 in this respect describes a function M(v) of the wheel torque plotted against the speed of a vehicle. A band 2 is placed around this curve 1 forming a closed range of driving parameters in the plane spread out by the wheel torque and the vehicle speed. Curve 1 is plotted during stationary travel. A discontinuity 3 results in the course of the band 2 in the operation of the vehicle with a trailer. For the sake of clarity, the course of the band 2 with the discontinuity 3 decisive for the trailer operation is shown in dotted lines and offset with respect to band 2. At a defined value VS of the vehicle speed, the ranges of driving parameters (illustrated by the values T1 and T2) of the wheel torque M are plotted against another driving parameter such as the lateral acceleration Q (illustrated in Figure 1b) or the yaw rate $\dot{\Psi}$ (illustrated in Figure 1c), whereby completely closed ranges of driving parameters are achieved. Only the reference values lying within these ranges of driving parameters are admitted as valid reference values.